C-3.1 Predict the type of bonding (ionic or covalent) and the shape of simple compounds by using Lewis dot structures and oxidation numbers.

Revised Taxonomy Level 2.5-B Infer (predict) conceptual understanding

In Physical Science students

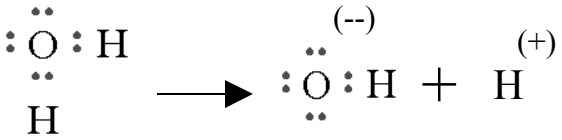
- Explain the role of bonding in achieving chemical stability. (PS-4.1)
- Explain how the process of covalent bonding provides chemical stability through the sharing of electrons. (PS-4.2)
- Illustrate the fact that ions attract ions of opposite charge from all directions and form crystal lattices. (PS-4.3)
- Classify compounds as crystalline (containing ionic bonds) or molecular (containing covalent bonds) based on whether their outer electrons are transferred or shared. (PS-4.4)
- Predict the ratio by which the representative elements combine to form binary ionic compounds, and represent that ratio in a chemical formula. (PS-4.5)

It is essential for students to

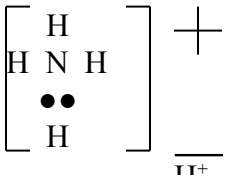
- Understand that the structure of molecules is the result of nonmetals sharing electrons in order to form stable outer-energy-level configuration. (covalent bonds)
  - Understand that because orbitals in the outer energy level of an atom are most stable when they contain two electrons, a covalent bond is likely to form between two elements which will both achieve the status of a full orbital in the outer energy level.
    - Covalent bonds are common between two elements, each having one or more orbitals in the outer energy level containing only one electron.
  - Understand how single, double, and triple bonds are formed.
  - Understand that the "s" and "p" orbitals in the outer energy level of each atom provide four possible bonding sites (except for the elements which achieve He structure)
  - Understand the 3-dimensional nature of molecules (tetrahedral bonding site structure)
  - Explain the shape of simple molecules such as water and carbon dioxide using VESPR
  - Draw Lewis dot structures for simple molecules
- Understand that crystalline structure is the result of the ionic bonding of positive and negative ions, forming a neutral compound.
  - The sum of the oxidation numbers in the formula of any neutral compound is zero
  - Understand that metallic atoms can form positive monatomic ions by losing electrons in order to achieve a stable outer energy level electron structure
  - Understand that nonmetal atoms can form negative monatomic ions by gaining electrons in order to achieve a stable outer energy level electron structure
  - Know that the oxidation number of a monoatomic ion is equal to its charge
  - Know the oxidation number of the monoatomic ions formed from elements in the following groups of the periodic table
    - Group 1, +1
    - Group 2, +2
    - Group 16, -2
    - Group 17, -1
    - Understand that some covalently bonded groups of atoms (similar in structure to molecules) act like single atoms in forming ions. These charged groups of covalently

bonded atoms are called polyatomic (many-atomed) ions and may be positive or negative.

- This most frequently occurs when a molecule loses one or more hydrogen ions (H^+), leaving the species negatively charged, such as the disassociation of water into a hydroxide ion (OH^-) and a hydrogen ion (H^+)



- The ammonium ion is formed when a molecule of ammonia, (NH_3), combines with a hydrogen ion, (H^+), resulting in a positively charged species. (NH_4^+)



- Such a species is called a polyatomic ion
- Understand that the oxidation number of a polyatomic ion is equal to its charge
- Understand that polyatomic ions react exactly the same as monoatomic ions in chemical reactions
- Use Lewis dot formulas to demonstrate ionic bonding

Assessment Guidelines

The objective of this indicator is for students to <u>infer (predict)</u> the type of bond and the shape of a simple compound (draw a logical conclusion) based on the outer energy level electron structure of the component elements. As this is <u>conceptual knowledge</u> (knowledge of the interrelationships among the basic elements within a large structure that enable them to function together) the primary focus of assessment should be to show that students can use knowledge of chemical stability and the relationship between an element's position on the periodic table and outers-level electron arrangement to predict whether an atom will gain, lose or share electrons, and how many electrons will be involved. In addition, students should have an understanding that many atomic properties are a result of an atoms tendency to gain or lose electrons.